Mechanical Design of a 4-Stage ADR for the PIPER mission

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XARM/RESOLVE

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- Purpose of 4-Stage ADR
- Design Overview
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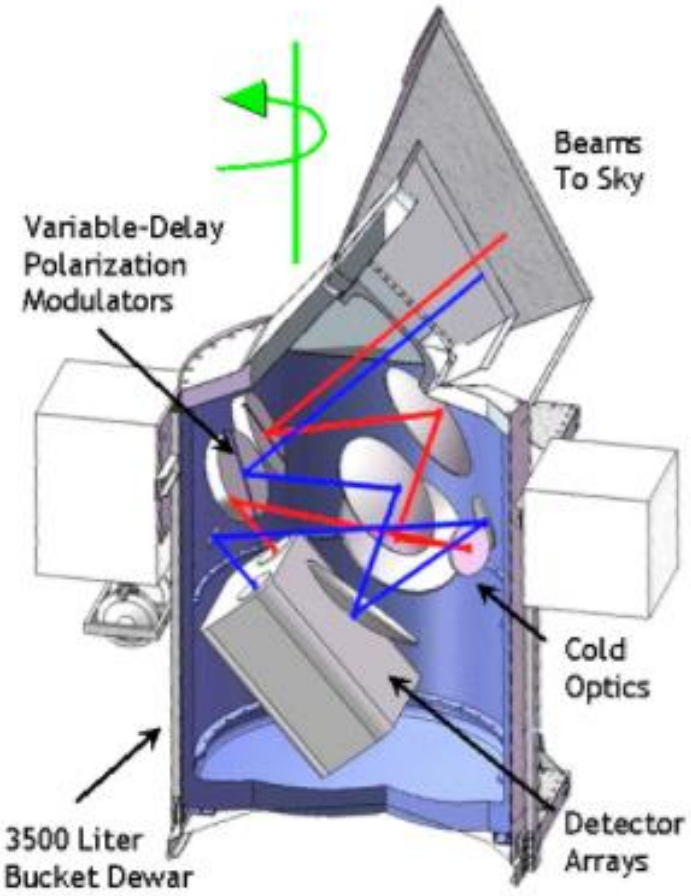
PIPER Mission Introduction

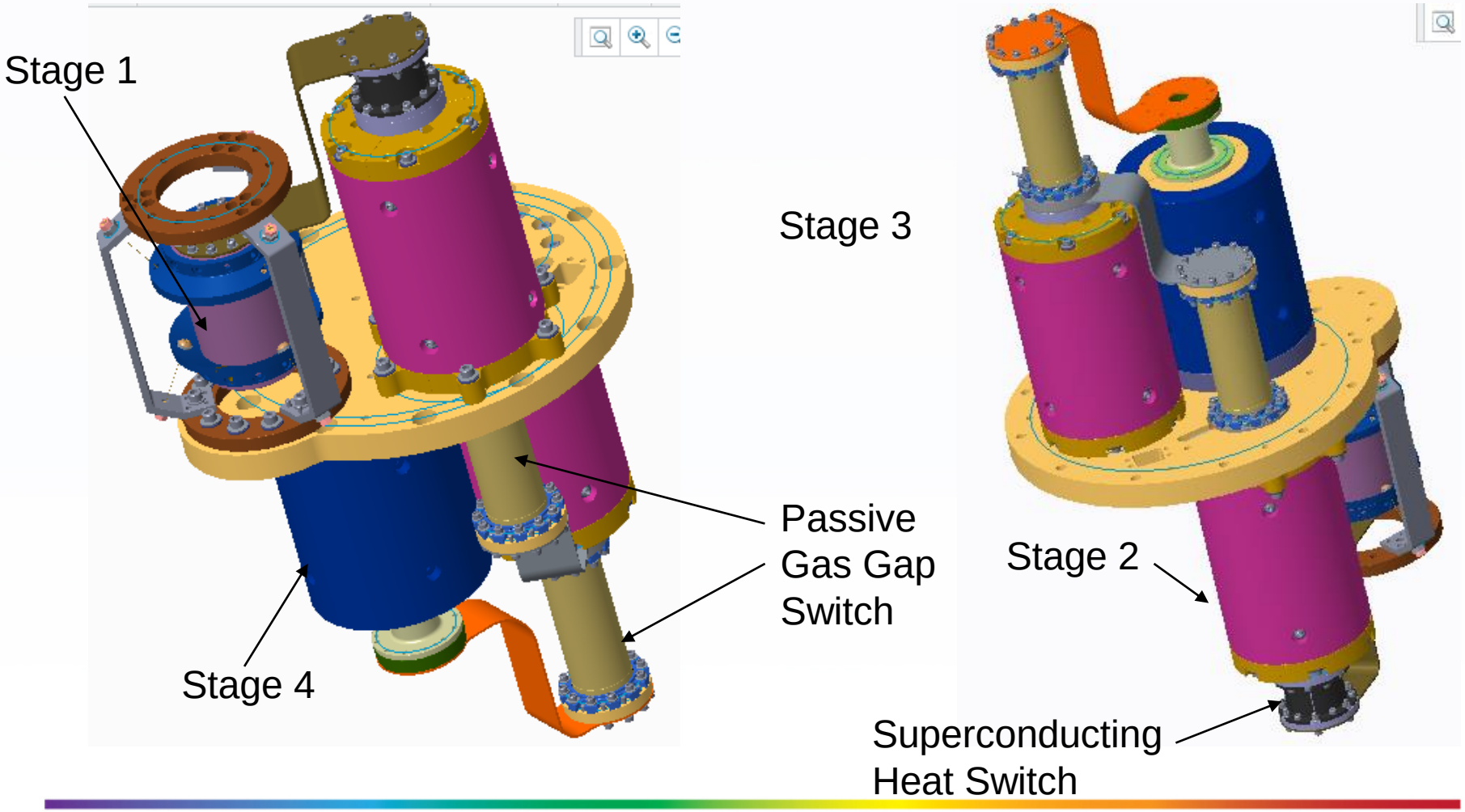
- The Primordial Inflation Polarization Explorer (PIPER) mission is a balloon borne mission that will fly 4 1280 bolometer detector arrays to measure the polarization of the cosmic microwave background.



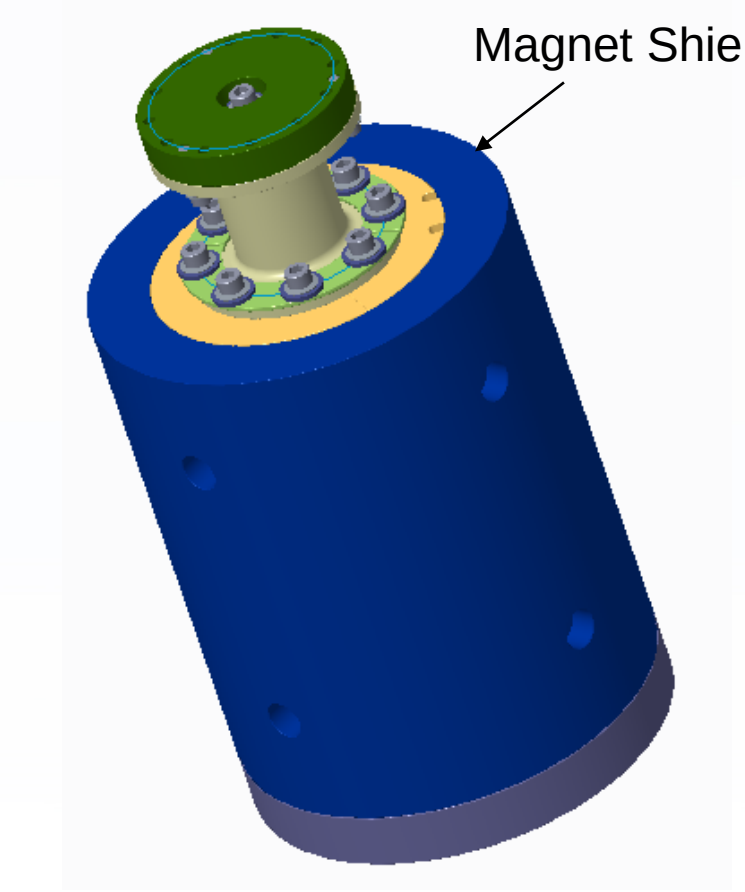
Purpose of 4-Stage ADR

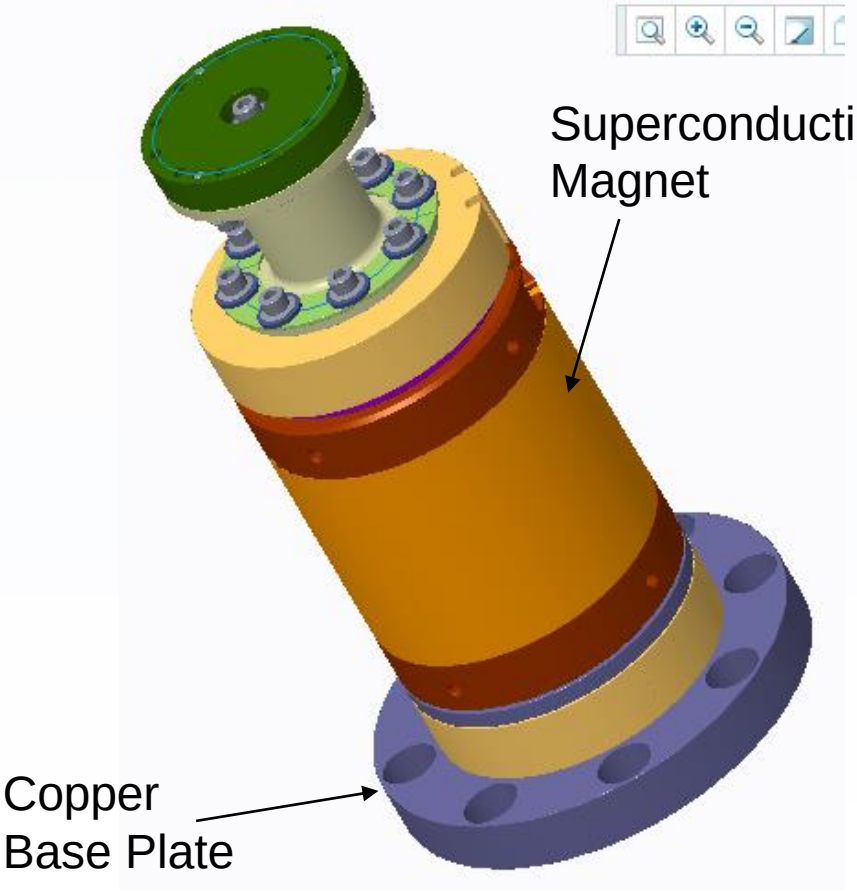
- The 4-stage adiabatic demagnetization refrigerator (ADR) is needed to cool the detector arrays to prevent instrument-generated heat from overwhelming the signal PIPER seeks during the mission.

Design Overview



Stage 4





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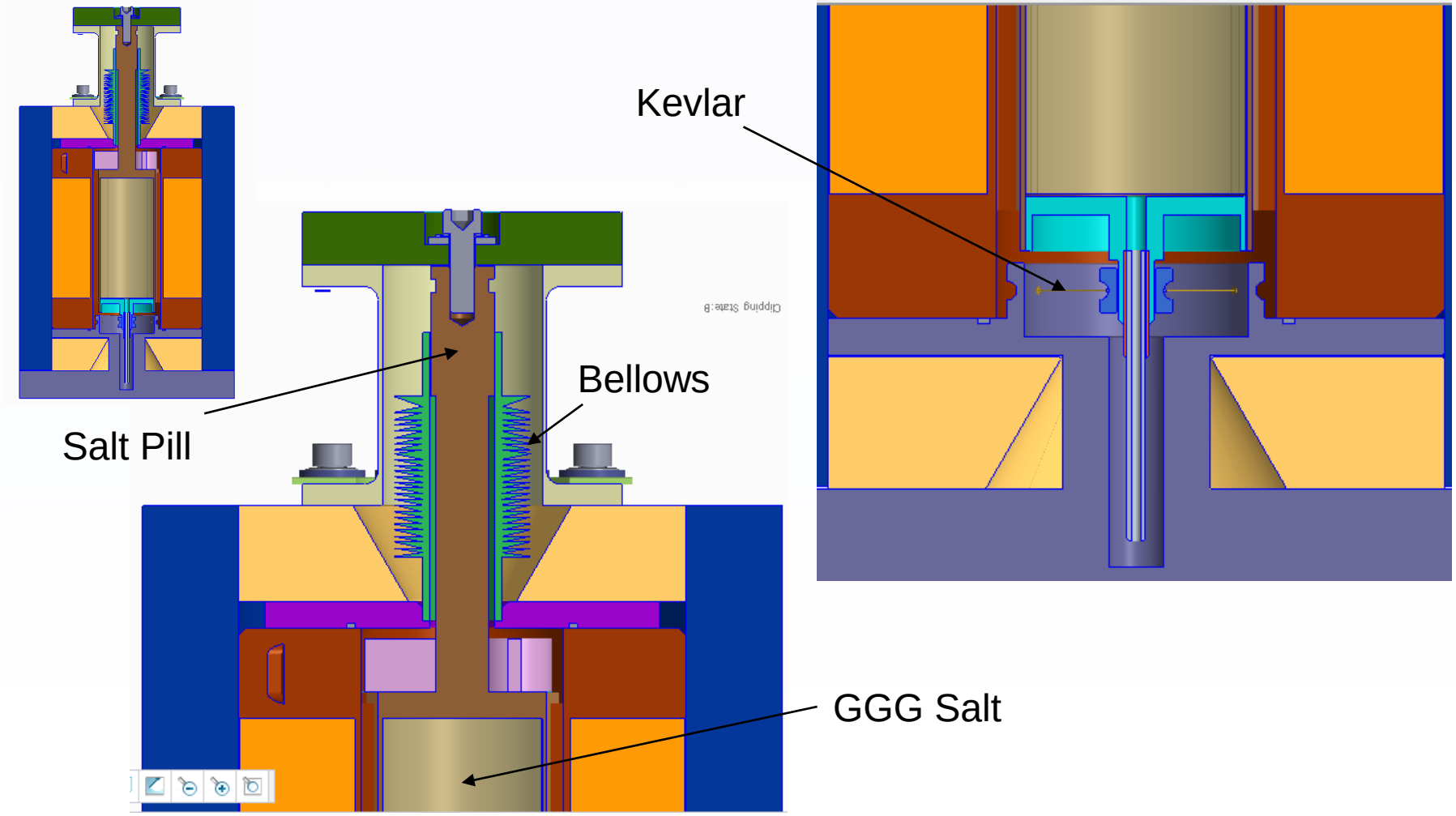

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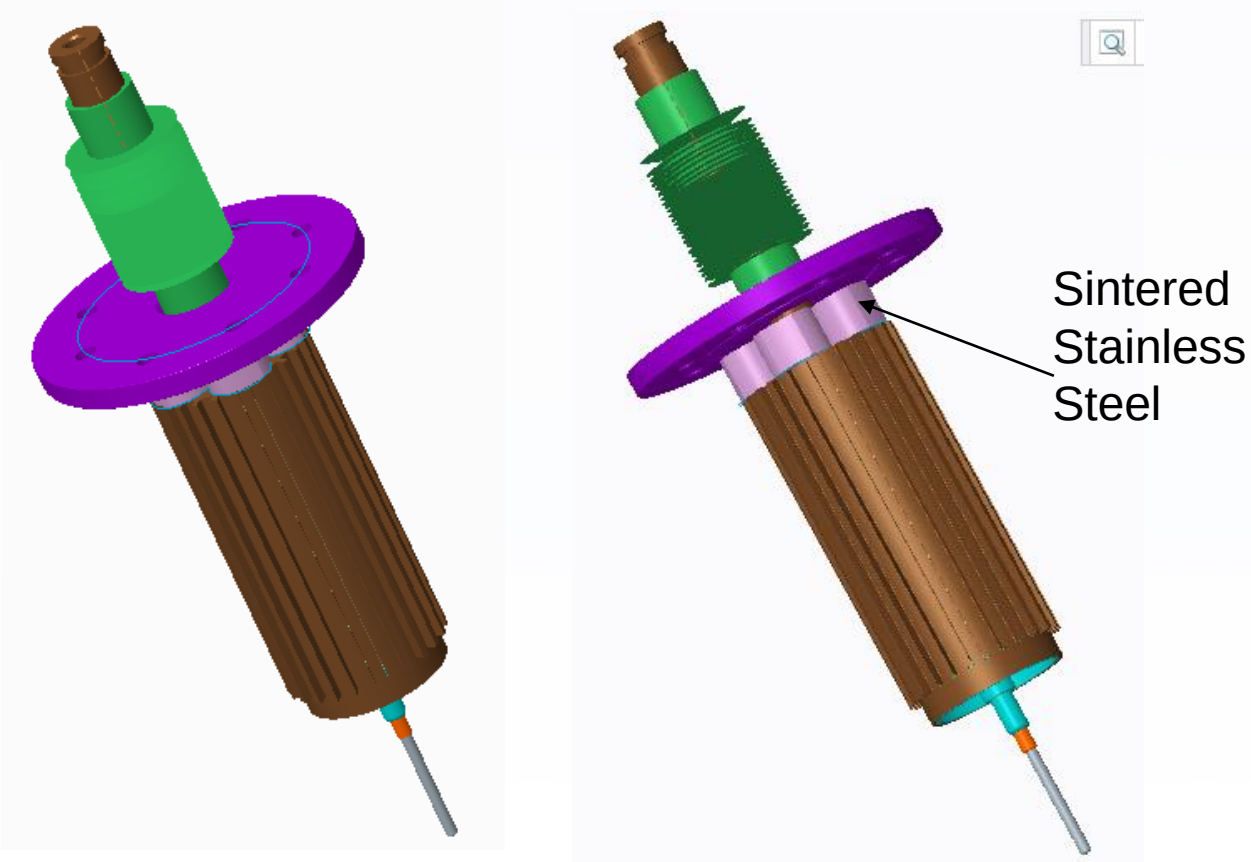
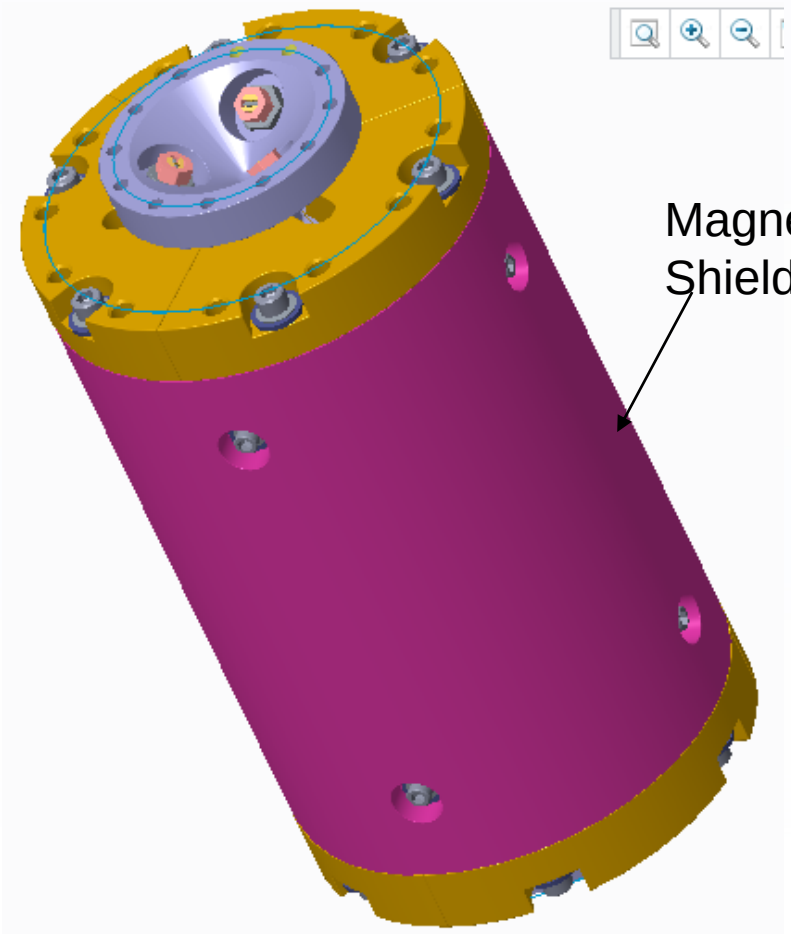
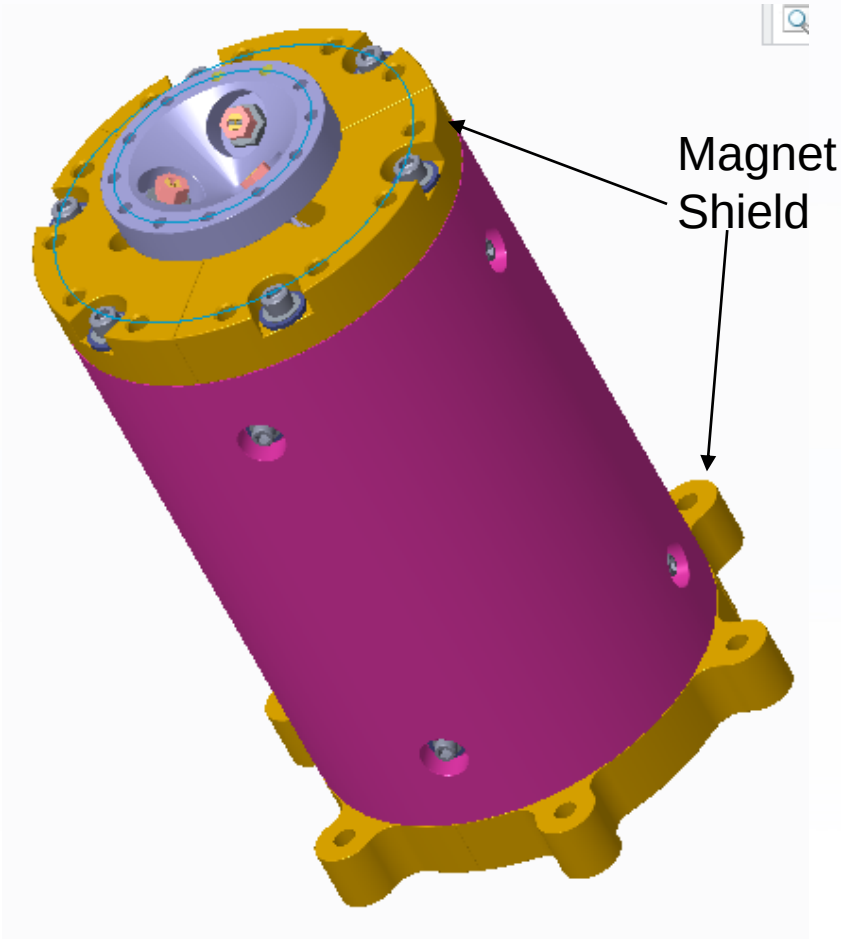
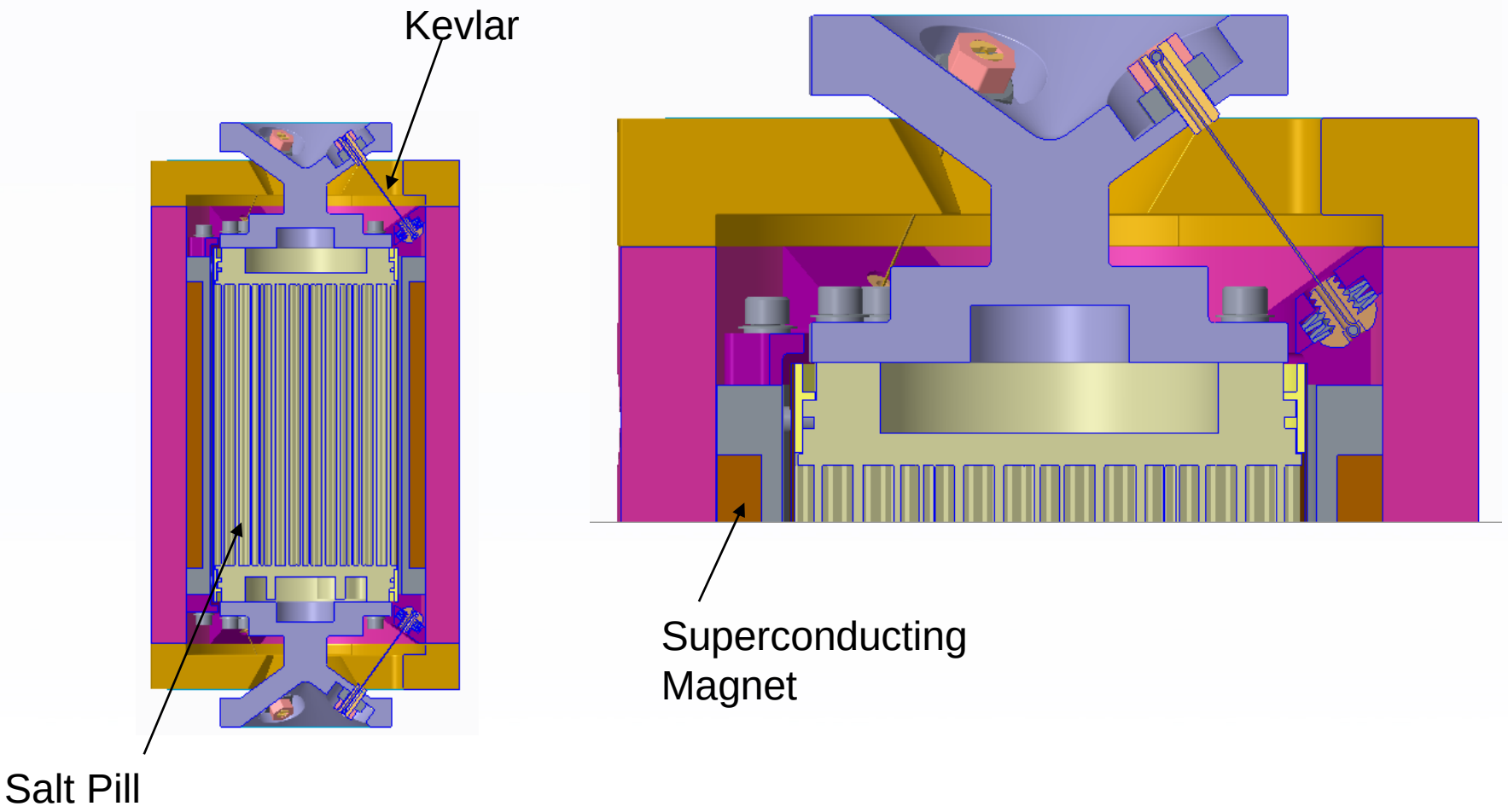


Stage 2 and Stage 3





Stage 2 and Stage 3 cont.



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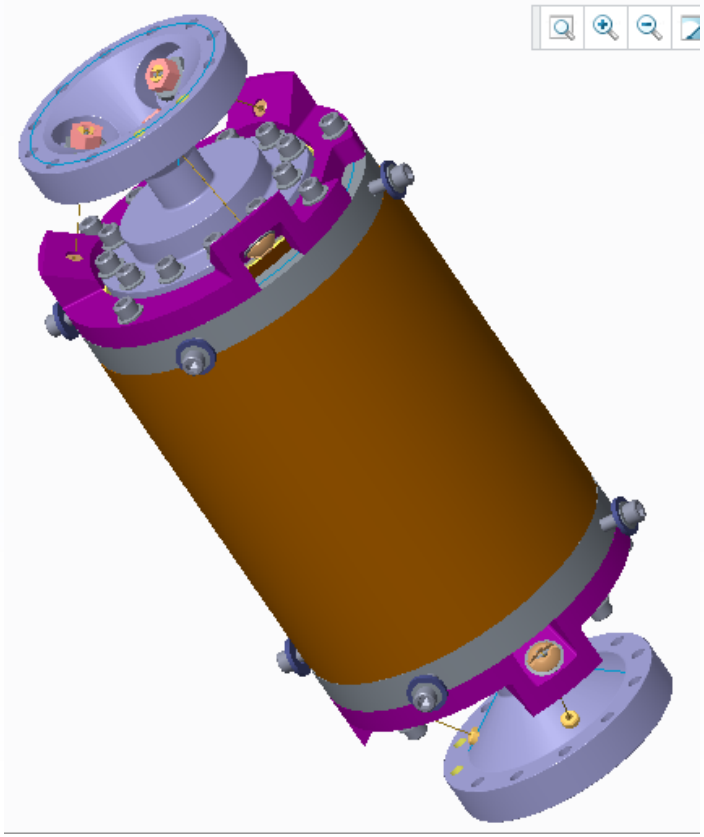
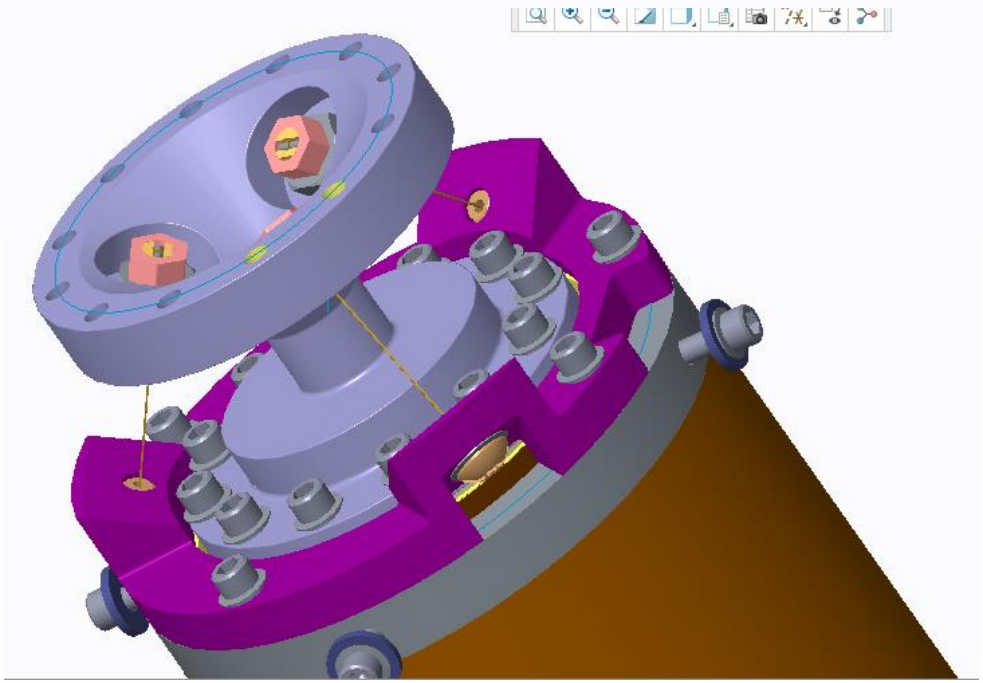
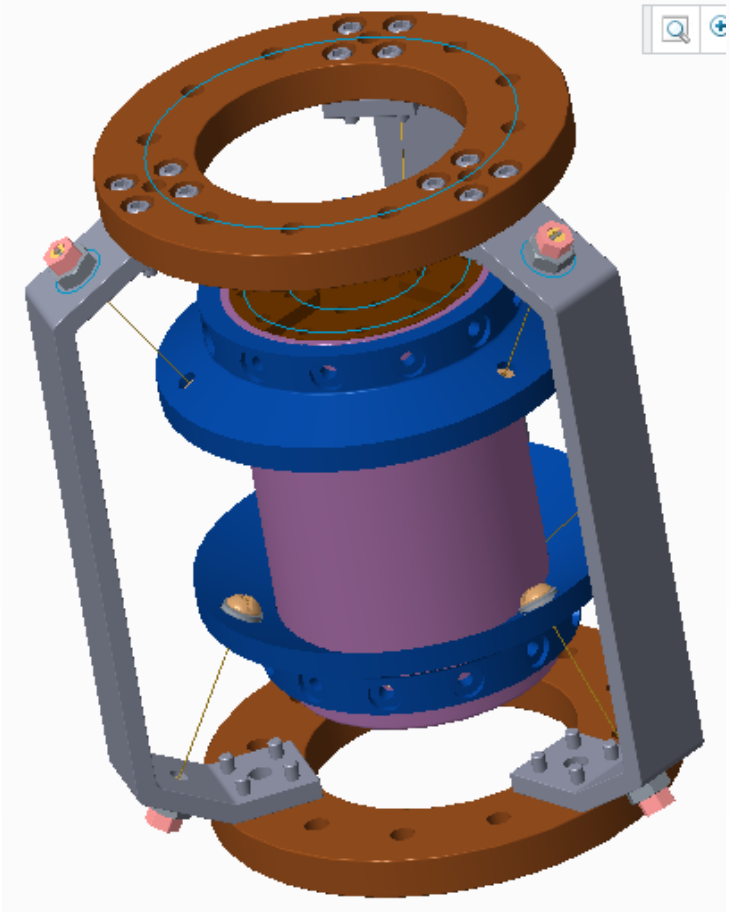
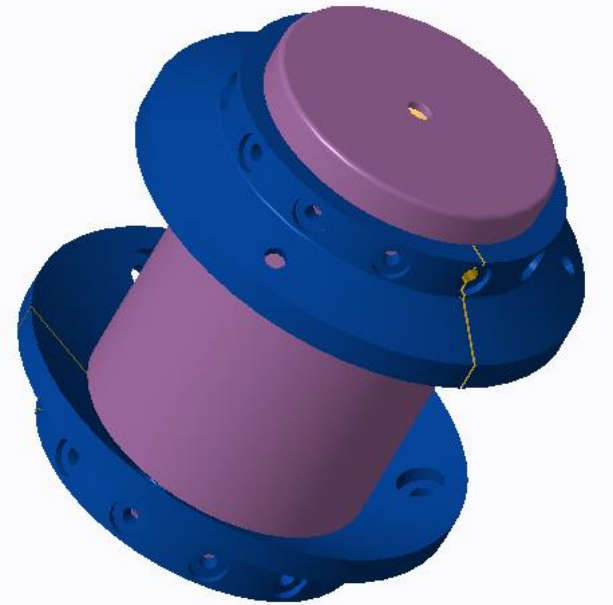


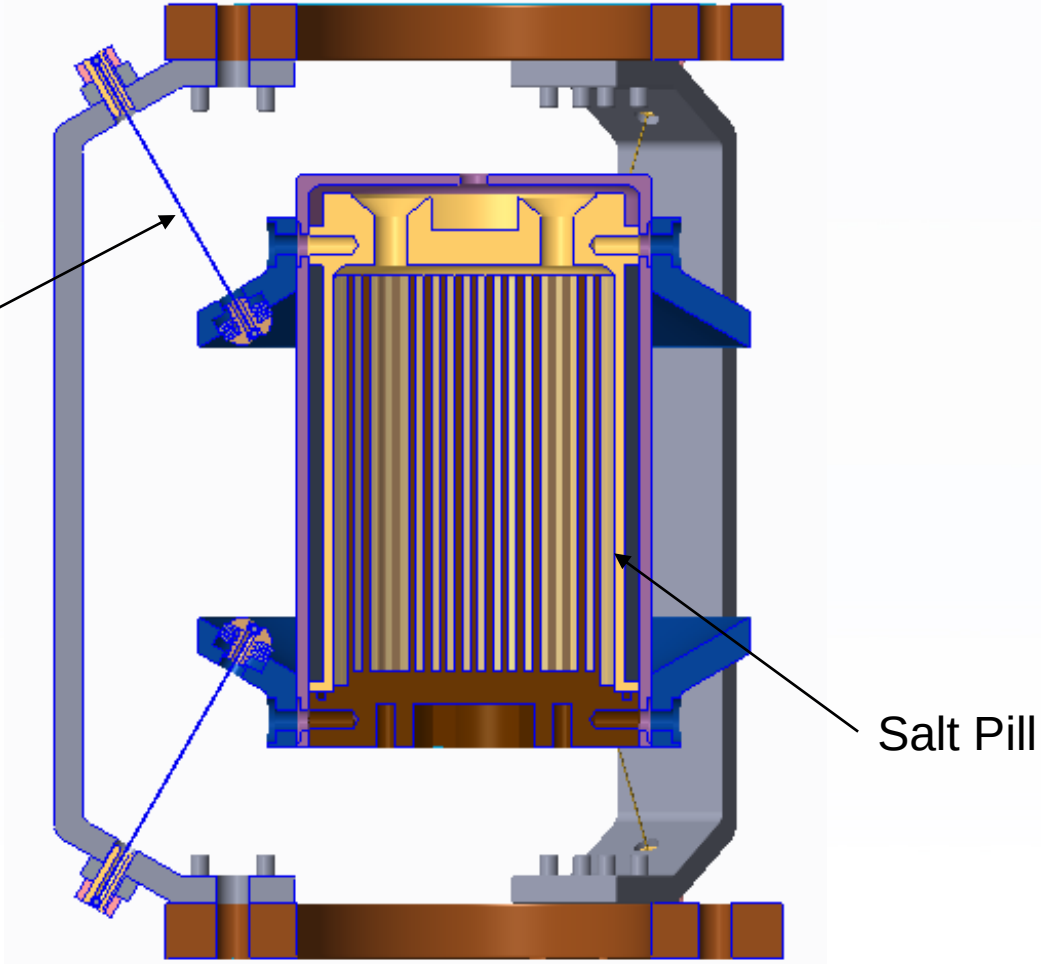


Stage 1

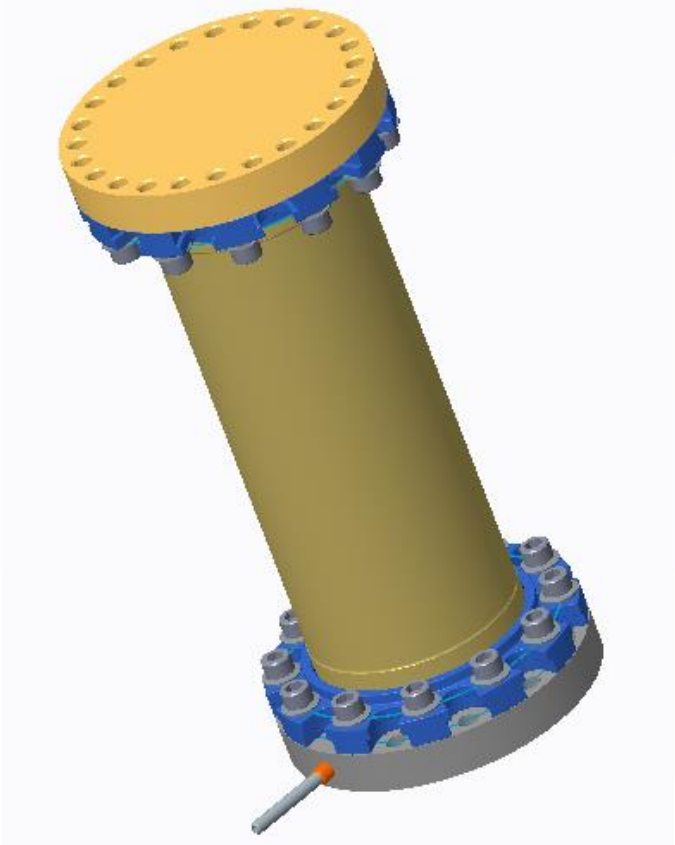


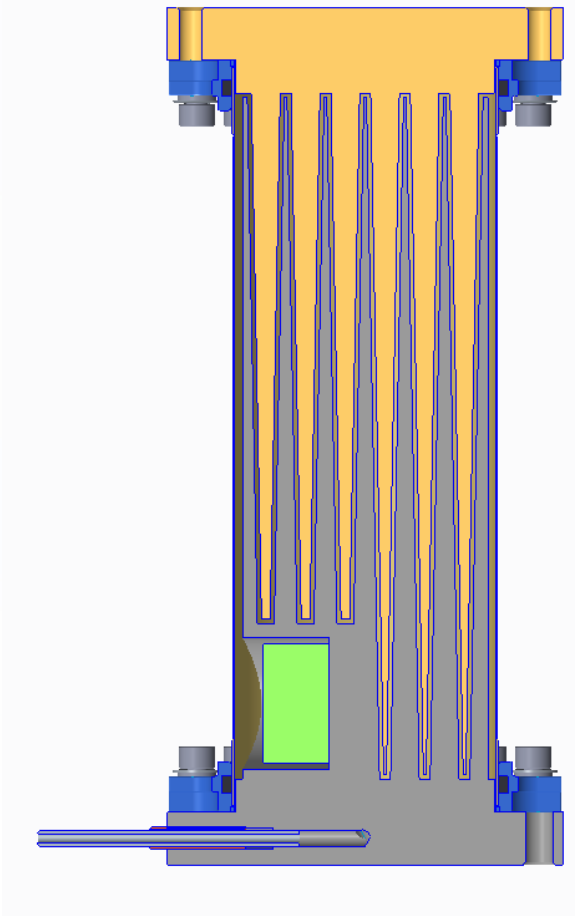


Stage 1 cont.

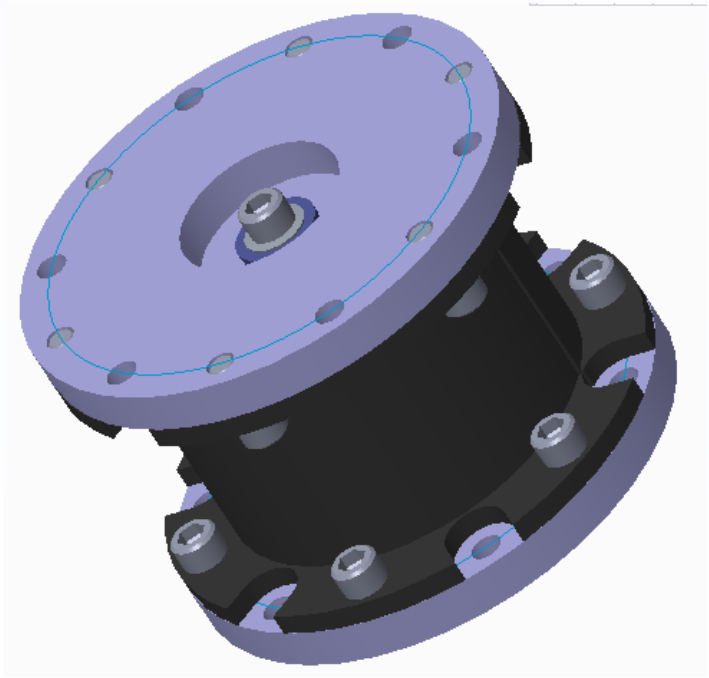


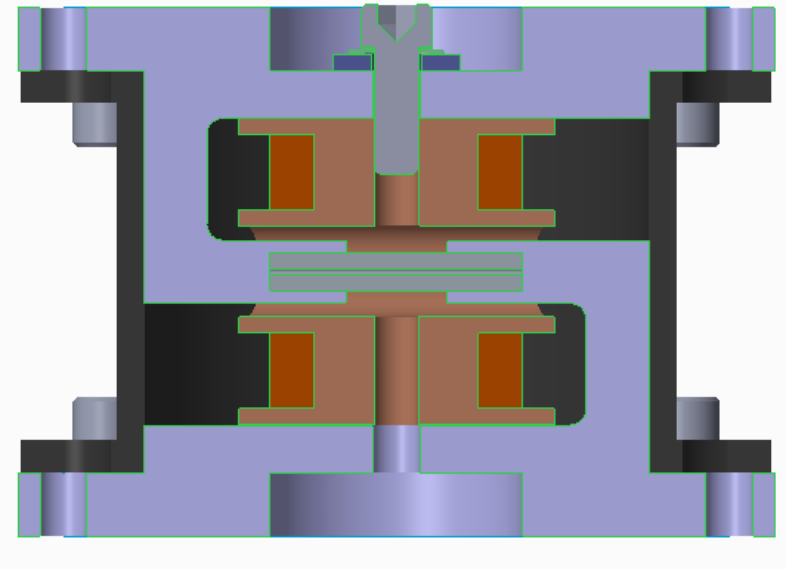
Passive Gas Gap Heat Switches





Superconducting Switch



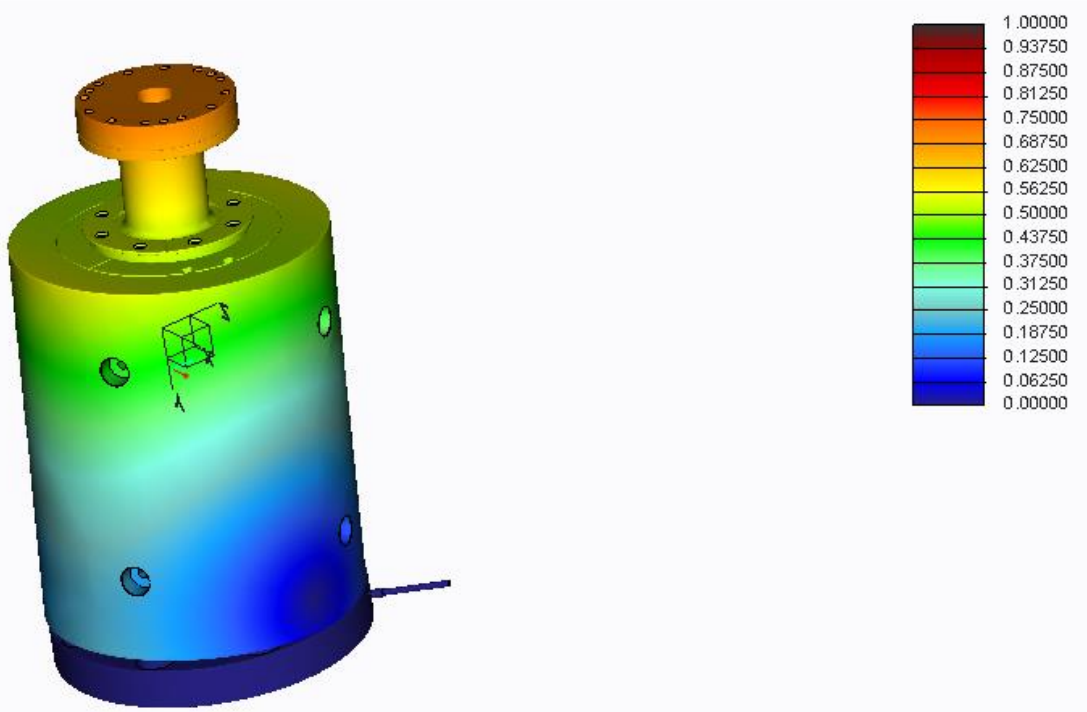


Materials

Material (-/-)	Tensile Modulus (ksi)	Yield Strength (ksi)	Ultimate Tensile Strength (ksi)	Poisson's Ratio (-/-)	Density (lbm/in^3)	Notes: (-/-)
Copper 10100	17000	45.0	50.0	0.31	0.323	H04 Full Hard ASTM B187 Rockwell F65 99.99% pure
Aluminum 6061-T651	10000	40.0	45.0	0.33	0.098	Rockwell A 40
Vespel SP1	475	12.5	12.5	0.41	0.052	Unfilled Rockwell E45
GGG Salt	-	-	-	-	0.256	Gadolinium Gallium Garnet
304 Stainless Steel	29000	31.2	73.2	0.29	0.289	Rockwell B 70
70-30 Copper-Nickel	22000	18.0	45.0	0.34	0.323	
Niobium-Titanium Wire	13488	54.7	105.6	0.40	0.276	
Silicon Iron C	28500	75	95	0.26*	0.274	Rockwell B 95
Kevlar 49 195 Denier	13900	348.4	348.4	.35	.052	

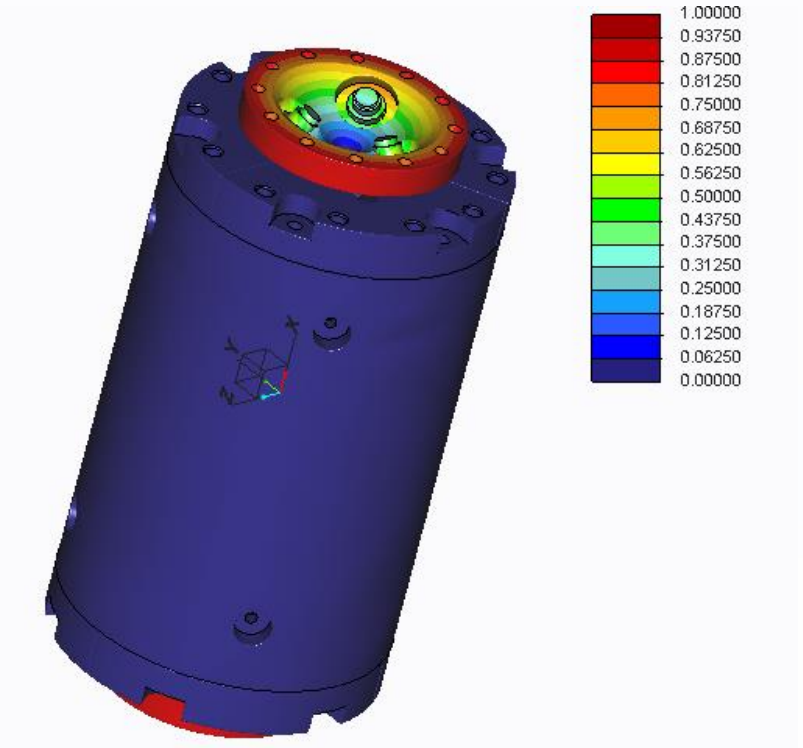
Results cont.

- Mode Frequency (Hz) Convergence
- ---- ---------- ----------
- 1 9.123538e+01 4.5%
- 2 9.149595e+01 4.9%
- 3 1.644186e+02 3.6%
- 4 1.646613e+02 3.5%



Results cont.

- Mode Frequency (Hz) Convergence
- ---- -------------- -----------
- 1 8.388150e+01 4.4%
- 2 8.407365e+01 4.8%
- 3 1.003635e+02 3.8%
- 4 1.005206e+02 3.9%



Results cont.

- Mode Frequency (Hz) Convergence
- ---- ---------- ----------
- 1 7.887332e+01 4.4%
- 2 8.707665e+01 4.8%
- 3 1.103195e+02 3.8%
- 4 1.105206e+02 3.9%